DAVID D. TERRY LOCK AND DAM
EXPERT SPILLWAY GATE CONTROL SYSTEM

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INTRODUCTION

The David D. Terry Lock and Dam project is a result of an initiative which grew from the Galveston District Senior Leaders Conference of 1989. The project is a prototype with an Expert System (Expert) controlling a personal computer based SCADA control network. The Expert is being designed by WES with guidance from LRD.

The project is twofold. The first phase was the Operations and Maintenance phase which replaced the obsolete tainter gate remote control and position indication at David D. Terry Lock and Dam. The second phase or special project portion is to program an expert system which will be discussed by Dr. Barry McCleave from WES. The personal computer (PC) based control system replaced an obsolete system of remote controls (pushbuttons) and remote indication (selsyn indicators) installed during dam construction to raise and lower gates from a remote shelter located on the lock wall.

SYSTEM DESIGN

The control system highlights are automatic control of gate positions, accurate measurement of gate position and water level, operator interface with graphic displays and menu driven functions, data collection and archival, and report generation. The system has communications capability to retrieve data from Murray Lock and Dam (upstream) and to pass upstream and downstream data to the Expert System. The Little Rock District (LRD) Office has communications capability to retrieve data from David D. Terry Lock and Dam. Three control modes are available to the operator:

- Basic operation from the control panel at each gate machinery platform. (Fall back manual operation)

- Remote operation from the control shelter on the lock wall using the Operator Interface Display (OID) unit. The unit is an industrial keypad panel mount type.

- Remote operation from the control house using a keyboard, mouse and CRT. Modes are Automatic/Operator or Automatic/ Expert.

DOWNSTREAM PROJECT (DAVID D. TERRY LOCK AND DAM)

The downstream project design can be broken down into two basic components, i.e. (1) The **PLC** system, and (2) The **SCADA** System. See attachments. The objective of the **PLC** system is to gather local data (status) such as gate position, gate flow, spillway flow, motor overload, and local-remote switch position and to operate interposing relays (control) to move the gates. The gate position is obtained through the use of incremental shaft encoders (hall-effect type) that provide a digital square wave output to the PLC counter module. The encoders are driven by a chain that is sprocketed to a small shaft connected the large hoist drum shaft. The tainter gates are raised by the hoist using wire rope cables which wrap on the drum when moved by an electric motor (similar to a winch). The objective of the **SCADA** system is to provide a graphical man machine interface to the PLC status and control functions on the downstream project, to gather data on the upstream project, to pass this data to the Expert, then move the gates using standard gate control (see attachments) as requested by the Expert or the operator. Also, the district uses a dial-up phone line to retrieve data recorded by the SCADA system.

Hardware and Software Vendors

A PC, programmable logic controllers (PLCs), remote control modules (RCMs), incremental shaft encoders (square wave output), fiber optic communication network (for the PLCs), dial-up modems, SCADA software package, Dynamic Data Exchange (DDE) communication server, and remote file transfer software were provided to accomplish the project. Major equipment vendors of the hardware are: PC - Gateway, PLC and RCMs - Square D, Encoders - Handar, and Fiber Optic Equipment - 3M. Major equipment vendors of software are: SCADA software - Wonderware InTouch, PC operating system - Microsoft Windows 95, file transfer (David D. Terry Lock and Dam to the District Office)- Carbon Copy, and serial communications (David D. Terry Lock and Dam to Murray Lock and Dam, SCADA to Expert, and SCADA to data collection platform (DCP)) - DDE server written in Delphi Borland International

(windows based).

UPSTREAM PROJECT (MURRAY LOCK AND DAM)

The upstream project data acquisition system was existing when this project started. It is a UNIX based system that collects data from an RS 485 serial bus that uses Handar serial ASCII incremental shaft encoders. The system was installed by U.S. Geological Survey (USGS) for Little Rock District and was designed primarily for data acquisition by the District via GOES satellite. The system was modified to store data and allow dial-up by the David D. Terry Lock and Dam SCADA system. The USGS system provides gate position, headwater, tailwater, spillway flow, hydroflow, and rainfall information on Murray Lock and Dam.

PROGRESS TO DATE

The SCADA portion of the project was constructed under two separate contracts. The first contract was for the SCADA, PLC, tainter gate position and remote control equipment at David D. Terry Lock and Dam. It was completed in 1994. The second contract was required to revise the standard gate control operation, provide an interface to the Expert, change control data from gate feet to spillway flow, address tainter gate position equipment problems and to interface with the upstream project data. It is still on-going as of this date. It is planned to load and test the Expert System this fiscal year. Also, PC hardware and software upgrades are being considered at Terry and Murray Lock and Dams to improve communications and task handling capabilities.

LESSONS LEARNED

The project has been on going for approximately eight years. I have been involved with the project for approximately five years. Many of the lessons learned can be applied to other projects. The following is a brief list of such lessons in order of importance:

DOWNSTREAM PROJECT (DAVID D. TERRY LOCK AND DAM)

- When automating a standard operating procedure (SOP) such as the moving the tainter gates keep the key players involved (operator, engineer, programmer, lockmaster). Let the user explain the SOP, then write it down and tell him how you

understand it, then do the same with the programmer. Also, a simulation at the programmer's facility is most beneficial. Keep in mind that you can't cover all situations and there are many limitations. Keep it simple if you can. We had a lot of meetings, letters, and revisions.

- When interfacing different systems it is best to keep a direct line of communication between the two programmers. Don't try to pass information back and forth.

- Dial-up phone line data retrieval. To date, this method of acquiring data has been at best functional only about fifty percent of the time. This method is probably the least cost, but I would not recommend it for critical data with short and frequent dial-ups.

- If at all possible, include a remote file transfer or remote monitoring package in the contract for the maintenance engineer or technician. This will allow personnel to login to the system remotely and perform maintenance or aid in troubleshooting before going to the field. In some cases it may eliminate a trip to the field.

- Position encoder calibration. The Dixson paper discusses power loss as it affects the encoder. Another concern is keeping the encoder calibrated. We have used rotational shaft counters in the past but they have been known to lose position. It is recommended that a gate calibration procedure be developed for a gate during higher flow conditions.

- Transient voltage surge suppression (TVSS). This has been a problem at David D. Terry Lock and Dam due to the project being on the end of a long rural electric line. This is also covered in the Dixson paper.

- TVSS wiring, grounding, and location. All three had to be revised at David D. Terry Lock and Dam. The use of series TVSS on low amperage ac circuits requires separation of incoming and outgoing wiring to negate inductive coupling during the surge event. An isolated electronic ground is almost impossible to achieve and we were advised to bond to the surrounding steel with a low impedance ground. The TVSS should be located as close as possible to the device being protected with the TVSS ground tied to electronic device chassis, and then from there to ground using a low impedance

path.

- Heat reduces battery life on the UPS and access to the UPS batteries should be considered. It is recommended that the UPS be free standing for ease of battery replacement and placed in an air conditioned room to increase battery life.

- Filter cleaning/replacement on all power supplies, PC's, UPS, etc. should be brought to the attention of the lock repairman. This is important and failures will occur if this service is not performed. Maintenance checklists have worked well.

- Be sure to include adequate spare parts in the contract. Time is of the essence when something is down. In some cases it could takes 3 weeks to get a part if not on hand. Also, keep the parts at the project site and make sure ahead of time that the project site has an adequate conditioned space to store the spare parts.

- UPS "Inverter On" alarms were common at our project in the beginning since it is in a rural area and inductive motors were coming on. We had to call the factory to increase the counts per spike allowed which helped. Also, in the MMI software a delay can be set to let the "Inverter On" alarm occur for a two to three seconds before notifying the operator.

- It is highly recommended to require a laptop in the contract for programming the PLCs. Also, be sure to keep the latest programs on the laptop and to keep the laptop at the project site.

- It is recommended that the "working copy" of the Operation and Maintenance manual be kept at the project site. Make an effort to place the latest information in the manuals or mark up the original material each time changes are made and maintenance is performed.

- It is recommended that a log book for the PLC and MMI be kept at the site to log changes, upgrades, problems/fixes, and preventative maintenance activities. This can be kept on the PC if desired.

UPSTREAM PROJECT (MURRAY LOCK AND DAM)

- Since the upstream project was an existing UNIX operating

system, the largest effort involved going thru the operating system to pull files off the hard disk. Again, this was done using dial-up modems. Initially, the dial-up was only successful when done without a login and password and this created security concerns. After making revisions to the Delphi DDE server the login/password procedure was worked out. The key was to make repetitive logins at each dial-up interval. The DDE server is a point to point process and at present a network configuration is being considered.

CONCLUSION

The project on the whole has been a great learning experience for myself, coworkers, and lock personnel. The SCADA portion is very near completion and the field installation of the Expert portion is just beginning. I am sure there will be some more changes in the future with upgrades and unforeseen conditions but the system is flexible enough to accommodate changes. I think the operators like the system and judging by the number of phone calls I get, I think they are taking full advantage of the system and there situation has improved.

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